Welcome to the TCORE 122D Web site.

Introduction to Science

Theme:
Thinking Systemically: How the World Works

Professor: George Mobus	Phone:	692-5894
	email:	gmobus@u.washington.edu
	Office:	Cherry Parkes (CP) 227
	Hours:	MTW 2:30-3:45pm, or by appoint.
Class:	Time:	MW 10:20-12:25
	Location:	PNK 104
Textbooks:	*Thinking in Systems: A Primer*, Chelsea Green Publishing, White River Junction, VT.	Meadows, Donella
	The Principles of Systems Science (Web Resource or Coursepack).	Mobus, George

Background

Read this short essay on Systems Science. In addition you should read this article on Wikipedia, Systems Science.

Objectives

This is a course about *understanding* how the world works. Or, perhaps more precisely, understanding how we understand how the world works!

In this course you will be introduced to the subjects of systems science and systems thinking. The former is the umbrella under which we catagorize and arrange various theories, tools, and techniques for investigating the world as a system of multiferous subsystems, all of which interact in various ways. The normal sciences investigate particular phenomena within particular disciplines such as biology or physics or economics. Systems science investigates the properties and behaviors of objects within all of those sciences that are common across them all.

The world (and we should say the Universe) is organized into large and small-scale objects that share certain common properties. We call them, in general, *systems*.

In this course you will learn about these properties and about the principles that have been derived by systems science to explain how all systems work no matter their composition, size, shape, or behavior. You will learn about and even start to practice the style of thinking that comes out of understanding the principles of systems science. We call it systems thinking, or thinking systemically. Once you get hold of the basic ideas you will begin to see the world in a wholly different way (unless, of course, you are already a systems thinker!)

Prerequisite:

Basic math skills (algebra) and a lab-based science in high school or college.

Student Learning Goals

With this course students will:

- Understand the big picture of science as a mode of inquiry into how the world works
- Understand systems science as a framework for how scientists think about the world
- Understand the basic principles of systems science and systems thinking
- Understand the application of systems science and systems thinking to various disciplines

Student Learning Outcomes

Core Student Learning Outcomes include:

- science (NW): define the sciences as an academic discipline
- inquiry & problem solving: collect, evaluate, and analyze information and resources to solve problems or answer questions
- research methods & application: approach complex issues by taking a large question and breaking it down into manageable pieces
- synthesis & context: make meaningful connections among assignments and readings in order to develop a sense of the ?big picture?
- analysis: identify, analyze, and summarize/represent the key elements of a text
- disciplinary awareness: enter/place themselves into an existing dialogue (intellectual, political, etc.)
- expression of ideas: express ideas clearly in writing and speaking in order to synthesize and evaluate information before presenting it
- disciplinary perspective: understand events and processes as ?disciplinarily? situated

After completion of this course, students will be able to apply systems thinking in multiple domains of interest, including the ability to:

- Identify systemic components and their interactions in a problem domain
- Construct a conceptual model of a system
- Apply systems principles to identify the dynamics (behavior) of systems
- Understand how dysfunctions within systems produce problems
- Show how many different problem domains can be approached with systems thinking
- Demonstrate an ability to build a small system model on a computer (in Excel)

Topics Covered

- Introduction to Scientific Inquiry
- The Nature of Systems
- The Principles of Systemness
  - Wholeness
  - Systems and Environments, Subsystems, Components
  - Network Structures & Complexity
  - Dynamics ? Processes, Functions, Behavior
  - Communications, Information, and Knowledge
  - Change Over Time
- Applications of Systems Thinking

- Analyzing a sustainable community as a system
- Building a model of the community ? play ?what-if? games
- Identifying potential problems in the systems and considering potential solutions
- Design approaches

Activities and Assessment

Readings

The course readings include a textbook by Donella Meadows who is recognized as an eminent systems scientist and thinker. This book is highly accessible to all college-age readers and provides a great overview of the systems approach to doing science. You will be expected to make steady progress in reading this book during the first half of the course as it will provide background for the activities we will do in the second half. You will have access to the slides that I use in classes. Links to these are given below.

We will be discussing subjects found in the book/Web site in classes as we try to find how they relate to one another. So keeping up on the reading is essential to getting all you can out of the classroom.

Each week we will engage in in-class activities that will be graded. These activities will depend on your having read the assigned reading over the prior weekend. You are advised to take notes on the readings, especially when something is not clear. The first hour of class each week will be devoted to explanations and getting questions answered before we start the in-class graded activity.

Graded Activities

Grades will be based on the below activities and their assessment for quality. Participation counts for 20% of the grade. I will be keeping tabs on each person's participation in discussions and give special consideration to the raising of questions that generate good discussion. If you do not show up it will be hard to accumulate points.

Weekly Seminar Discussions (participation)

This exercise will be done on the first day of class each week. The second hour of class time the whole group will be engaged in a seminar-like session. This is where the professor will monitor your participation (20% of grade, remember). You will be expected to produce one of the following:

- An observation about the subject matter of the week that might generate further discussion. Good observations might include noticing how some principle considered in the current week seems related to something considered in prior weeks.
- A question about the subject matter - something you did not understand, or want to understand more deeply. Good questions are open ended in form and really good questions generate additional questions.
- A challenge to some aspect of the subject matter if you think it does not comport with your own understanding. This kind of participation will get the highest marks as long as your challenge demonstrates that you are using good critical thinking and not just challenging for the sake of getting a good grade!

You will be assessed for the quality of your statements/questions showing that you are thinking deeply about the subject. No points will be given to those who make a **rush** to **answer** a challenging question posed by someone else. We are trying to culture the skill of thoughtful and critical inquiry which is the basis of good science. You can even lose points if you try to answer a thoughtful question with an ill-considered opinion!

Weekly In-class Exercises (groups of 3-4)

The second involves in-class exercises to be held on the second meeting day of each week. In these exercises small groups of three of four students will discuss a topic from the readings or previous lectures and then be given time to develop answers to a set of questions given by the professor. The sessions will take up the second hour of the class. For each session the group will write their names on the turn-in sheet with the answers they all have agreed upon. These discussion/quiz exercises will run from the second week through the 9th week (eight in all). They will be graded and all members of that group will get the same grade. Each week we will attempt to shuffle the groups so that everyone will have worked with everyone else by the end. Taken together these exercises will amount to 20% of the final grade.

Project (a systems model - group of 3-4)

Another assessment component will be a team-based project and final report. The project will involve creating a systems model of some subsystem in a permaculture community. For example you might develop a model of the calories flowing from the gardens, fields, and orchards to the citizens in the community. There are a large number of subsystems to choose from. The model will consist of a systems dynamics diagram of the subsystem and a simple spreadsheet version to show how the model performs over time. There will be more information provided in the class. The team will write and present a final report during the last week of class before finals week. This component will represent 20% of the final grade. A grading rubric will be provided with the actual written assignment. The project will be worth 20% of the final grade.

Midterm Exam

The midterm will cover terminology and basic concepts that students will have needed to master. It will be closed-book, short answer and multiple choice. This test is 15% of the final grade.

Final Exam

The final component is the final. This will be an open book, open notes essay exam during finals week. Grammar and spelling will not be strongly graded since this is a timed, hand written test. However, grievous errors will result in a downgrade of the work. What is important in this exam is a demonstration of your ability to identify the relevant principles of systems science and/or permaculture for a given question and then summarize those in your answers. Examples will be provided later in the quarter. The final is worth 25% of your final grade.

Schedule

Week	Subjects Covered	Readings	Exercises
1	What is Science? What is Systems Science? What is Systems Thinking?	Meadows: Introduction & Chapter 1	In-class exercise based on reading General class discussion: Science as an Approach to Inquiry
2	Overview of Systems Principles General Systems Dynamics (Behavior)	Mobus: Review the slides Principles of Systems Science Meadows: Chapter 2 through page 58	Class discussion: Stocks and Flows (text book) .
	More Systems Principles (in-depth) and Systems Dynamics	Mobus: Principle 4	Class discussion:

3	and Systems Dynamics Energy, Matter, and Message Flows in Systems	Mobus: Principle 4 Meadows: Chapter 2, page 58 to end	Systems Principle 4 in greater detail.
4	How Systems Can Be Self-Managing and Self-Sustaining The Principle of Feedback and Self-Regulation	Mobus: Principles 7 & 8 Meadows: Chapter 3	Class discussion: Systems Principles 7 & 8 (Information and Cybernetics) in greater detail.
5	Systems Models, Our Mental Models, & Computer Models Midterm Exam	Mobus: Systems Principles 9 & 10 Meadows: Chapter 4	Class discussion: How to build a system model.
6	How Systems Evolve and Adapt to Change	Mobus: Principle 6 Meadows: Chapter 6	Class discussion: Emergence of new levels of organization and their evolution thereafter.
7	Complexity of Organization and Behavior	Mobus: Principle 5 Meadows: Chapter 4 (Review)	Class discussion: How evolution leads to increasing complexity.
8	When Things Go Wrong	Mobus: Principle 5, Complexity ? The Downside & Principle 8.1, Things Can Go Wrong Meadows: Chapter 5	Class discussion: How complexity becomes a problem; the law of diminishing returns.
9	Sustainability as a Problem in Systems Science Biophysical Economics as Systems Science Applied to Social Systems	Mobus: Supplied Reading Meadows: Chapter 7	Class discussion: How to understand the global socio-ecological system.
10	Systems Science as Science Writ Large	Mobus: Supplied Reading	No in-class exercise. Discussion and Review.
11	Final Exam		

Textbooks and Readings:

Meadows, Donella (2008). *Thinking in Systems: A Primer*, Chelsea Green Publishing, White River Junction, VT.

Mobus, George (2012). *Principles of Systems Science*, slides.

Slides on Systems Science

[The Principles of Systems Science]

Video Resources

[Connections], James Burke:

This is the first episode of a series that aired on PBS (from the BBC) back in 1978. For background see the [Wikipedia article].

As dated as this might seem, the points Burke makes in this episode are even more relevant today. The whole series is about how humans, science, technology, economics, etc. form a densely interconnected web of relations, in other words how our world is a system that is evolving over time.

I saw this show when it first aired and it really hit home with me how understanding systemness and systems thinking is essential to understanding how the world works. Burke went on to produce several more series along similar lines, but this first one is essential for understanding the themes in later ones.

I'm only assigning the first episode but I hope you will recognize the value of this perspective and sample a few others. They combine history, psychology, invention, science, and the natural world in ways you have never seen in the usual educational setting. On Wed. we will have the in-class exercise as given in the syllabus, but we will also spend some time discussing Connections and what thoughts you have about the topic(s).